For purposes of calculating filing fees please cancel claims as reflected on the complete listing of claims submitted herewith.

Listing of Claims:

Claim 1-16 Cancelled.

17.(Original) A method of synthesizing composite material comprised of a highly ordered colloidal crystal and a substrate, the method comprising the steps of:

a) providing a substrate having a surface with a selected surface relief pattern;

b) applying masking means to a portion of said surface so that said masking means is resting on raised portions of said surface;

c) applying a liquid dispersion containing colloidal particles of selected shape and size to an unmasked portion of said surface wherein said colloidal particles are drawn under said masking means by capillary forces and self-assemble into a substantially ordered colloidal crystal in void spaces on said surface defined by said relief pattern and said masking means; and

d) removing said masking means.

18.(Original) The method according to claim 17 wherein said masking means has a

substantially planar surface so that said planar surface is resting on raised portions of said surface when said masking means is applied to said surface.

19.(Original) The method according to claim 17 wherein said substrate is selected from the group consisting of insulators, semiconductors, glasses, polymers and metals.

20.(Original) The method according to claim 17 wherein said colloidal particles are spherical colloidal particles having a diameter in a range from about 0.1 to about 5 microns.

21.(Original) The method according to claim 21 wherein said spherical colloidal particles are made of silicon dioxide (SiO_2).

22.(Original) The method according to claim 17 including a step of consolidation of the colloidal crystal by thermal sintering or hydrothermal treatment in aqueous base and silica chemical vapor deposition resulting in necking of the colloidal particles.

23.(Original) The method according to claim 22 including a step of infiltration of the colloidal crystal with a selected material followed by a step of inversion to remove the colloidal particles to produce an inverted colloidal crystal pattern on said substrate.

24 (Original). The method according to claim 23 wherein said inverted colloidal crystal is a photonic crystal.

25.(Original) The method according to claim 24 wherein a ratio of air to the selected material is selected so that said photonic crystal is characterized by a photonic bandgap.

26.(Original) The method according to claim 17 including a step of depositing a layer of a selected material on top of the surface of said substrate containing said inverted colloidal crystal pattern.

27.(Original) The method according to claim 26 including a step of producing a selected surface relief pattern on a top surface of said layer of said selected material and repeating steps b), c) and d) according to claim 1 to produce a substrate with more than one inverted colloidal crystal pattern embedded within said substrate.

28.(Original) The method according to claim 27 wherein said more than one inverted colloidal crystal are photonic crystals embedded within said substrate.

29.(Original) The method according to claim 17 wherein said surface relief pattern is

produced using one of soft lithography and photolithography.

30.(Original) A method of synthesizing composite material of a colloidal crystal and a substrate, comprising:

a) providing a substrate having a surface with a selected surface relief pattern; and

b) applying a liquid dispersion containing colloidal particles of selected shape and size onto said surface and spinning said substrate whereby colloidal particles are swept across said surface and self-assemble in void spaces on said surface defined by said relief pattern.

31.(Original) The method according to claim 30 wherein said substrate is selected from the group consisting of insulators, semiconductors, glasses, polymers and metals.

32.(Original) The method according to claim 30 wherein said colloidal particles are spherical colloidal particles having a diameter in a range from about 0.1 to about 5 microns.

33.(Original) The method according to claim 32 wherein said spherical colloidal particles are made of silicon dioxide (SiO_2).

34.(Original) The method according to claim 30 including a step of consolidation of the colloidal crystal by thermal sintering or hydrothermal treatment in aqueous base and silica chemical vapor deposition resulting in necking of the colloidal particles.

35.(Original) The method according to claim 34 including a step of infiltration of the colloidal crystal with a selected material followed by a step of inversion to remove the colloidal particles to produce an inverted colloidal crystal pattern on said substrate.

36.(Original) The method according to claim 35 wherein said inverted colloidal crystal is a photonic crystal.

37.(Original) The method according to claim 36 wherein a ratio of air to the selected material is selected so that said photonic crystal is characterized by a photonic bandgap.

38.(Original) The method according to claim 30 including a step of depositing a layer of a selected material on top of the surface of said substrate containing said inverted colloidal crystal pattern.

39.(Original) The method according to claim 38 including a step of producing a

selected surface relief pattern on a top surface of said layer of said selected material and repeating steps b), c) and d) according to claim 1 to produce a substrate with more than one inverted colloidal crystal pattern embedded within said substrate.

40.(Original) The method according to claim 39 wherein said more than one inverted colloidal crystal are photonic crystals embedded within said substrate.

41.(Original) The method according to claim 30 wherein said surface relief pattern is produced using soft lithography.

42.(Original) A method of synthesizing composite material comprised of a colloidal crystal and a substrate, comprising:

a) providing a substrate having a substantially planar surface;

b) applying masking means to a portion of said surface, said masking means having a surface with a selected surface relief pattern with said surface being adjacent to said planar surface;

c) applying a dispersion containing colloidal particles of selected shape and size to an unmasked portion of said surface wherein said colloidal particles are drawn under said masking means by capillary forces and forming into a colloidal crystal by self-assembly in void spaces on said surface defined by said relief pattern and said planar

surface;

d) removing said masking means;

e) consolidating the colloidal crystal by one of thermal sintering, hydrothermal treatment and silica chemical vapor deposition to produce necking of the colloidal particles;

f) infiltrating the colloidal crystal pattern formed on the substrate with a material having a selected refractive index; and

g) removing the colloidal particles to produce an inverted colloidal crystal pattern embedded on said substrate.

43.(Original) The method according to claim 42 wherein said substrate is selected from the group consisting of insulators, semiconductors, glasses, polymers and metals.

44.(Original) The method according to claim 42 wherein said colloidal particles are spherical colloidal particles having a diameter in a range from about 0.1 to about 5 microns.

45.(Original) The method according to claim 44 wherein said spherical colloidal particles are made of silicon dioxide (SiO_2).

46.(Original) The method according to claim 42 wherein said inverted colloidal crystal pattern is a photonic crystal.

47.(Original) The method according to claim 46 wherein said photonic crystal is characterized by a photonic bandgap.

48.(Original) The method according to claim 46 including attaching light coupling means to said substrate for coupling light into said colloidal crystal or said inverted infiltrated colloidal crystal.

49.(Original) The method according to claim 47 including attaching light coupling means to said substrate for coupling light into said colloidal crystal or said inverted infiltrated colloidal crystal.

50.(Original) The method according to claim 42 wherein said surface relief pattern includes at least one indentation of selected geometry and depth formed in the surface.

51.(Original) The method according to claim 50 wherein said at least one indentation is a plurality of indentations across said surface forming a selected pattern.

52.(Original) A method of synthesizing composite material of a colloidal crystal and a substrate, comprising:

a) providing a substrate having a surface with a selected surface relief pattern;

b) dipping said substrate into a liquid dispersion containing colloidal particles of selected shape and size, wherein said liquid dispersion includes a solvent having an effective evaporation rate, and wherein evaporation of said solvent induces directional mass transport of said colloidal particles within said relief pattern, wherein said colloidal particles spontaneously self-assemble and crystallize between raised features of said surface relief pattern; and

c) removing said substrate from said liquid dispersion.

53.(Original) The method according to claim 52 wherein said surface relief pattern includes elongate channels extending across said surface, and wherein said substrate is dipped into said liquid dispersion such that said elongate channels are substantially vertical.

54.(Original) The method according to claim 52 wherein said elongated channels are inclined at a pre-selected angle with respect to the vertical.

55.(Original) The method according to claim 52 wherein said surface relief pattern is

produced by placing a PDMS elastomeric stamp patterned with a parallel array of micron scale rectangular-shaped micro-channels into conformal contact with said surface of the substrate, infiltrating an effective polymeric material into said micro-channels, polymerizing said polymeric material and then removing said PDMS elastomeric stamp leaving behind said surface relief pattern comprising rectangular-shaped micro-channels.

56.(Original) The method according to claim 53 wherein said effective polymeric material includes silica sol (from tetramethoxysilane and 0.1N oxalic acid (3:1 w/w)), organic modified silica sol (from mixture of 3-(glycidoxypropyl)trimethoxysilane, tetramethoxysilane and 0.1N oxalic acid 5:1:1 w/w) or pre-polymer (NOA-60 or NOA-73 polyurethane.

57.(Original) The method according to claim 52 wherein said liquid dispersion includes an alcohol.

58.(Original) The method according to claim 57 wherein said alcohol is ethanol.

59.(Original) The method according to claim 52 wherein said substrate is withdrawn from said liquid dispersion at a pre-selected rate.

60.(Original) The method according to claim 59 wherein said colloidal dispersion includes a 2-5wt% ethanolic suspension of mono-disperse silica micro-spheres that have diameters in a size range from about 350 nm to about 2500 nm diameter.

61.(Original) The method according to claim 60 wherein the rate of withdrawal of the patterned substrate from the ethanolic suspension is in a velocity range of about 0.5 to about 3 cm/s.

62.(Original) The method according to claim 61 wherein said particles have diameters in a range from about 600 nm to about 2500 nm, including stirring said liquid dispersion.

63.(Original) The method according to claim 60 wherein said surface relief pattern is formed directly in said surface.

64.(Original) The method according to claim 60 wherein said surface relief pattern is produced in a mold that is affixed to the surface of the substrate.

65.(Original) A method for producing a film of colloidal particles on a planar surface of a substrate, comprising the steps of:

a) dipping a substrate into a liquid dispersion containing colloidal particles of selected shape and having a mean diameter in a range from about 600 nm to about 2500 nm, said liquid dispersion including a solvent having a pre-selected rate of evaporation;

b) agitating said liquid dispersion in such a way so as to reduce sedimentation of said colloidal particles but not to disturb a meniscus that is formed between the planar surface and the liquid dispersion of colloidal particles, wherein evaporation of said solvent induces said colloidal particles to spontaneously self-assemble and crystallize on said planar surface; and

c) removing said substrate from said liquid dispersion.

66.(Original) The method according to claim 65 wherein said rate of evaporation is controlled by controlling the temperature of the liquid dispersion.

67.(Original) The method according to claim 65 wherein said colloidal particles are mono-disperse spherical particles.

68.(Original) The method according to claim 67 wherein said mono-disperse spherical particles are silica spheres and said film is an opal film.

69.(Original) The method according to claim 65 including a step of consolidation of the colloidal crystal by one of thermal sintering, hydrothermal treatment in aqueous base and silica chemical vapor deposition resulting in necking of the colloidal particles.

70.(Original) The method according to claim 69 including a step of infiltration of the colloidal crystal film formed on the substrate with a selected material followed by a step of inversion to remove the colloidal particles to produce an inverted colloidal crystal film on said substrate.

71.(Original) The method according to claim 70 wherein said selected material has a refractive index equal to or greater than about 3.2 so that a difference in refractive index between the selected material and air in the inverted colloidal crystal pattern is at least about 2.2.

72.(Original) The method according to claim 71 wherein said inverted colloidal crystal film has a photonic bandgap.

73.(Original) The method according to claim 65 including lithographically patterning said inverted colloidal crystal pattern to produce therein optical circuits.

74. (Original) The method according to claim 65 wherein the step of agitating said liquid dispersion includes stirring or producing a thermal convection gradient in said liquid.

75.(Original) A method of synthesizing composite material comprised of a colloidal crystal and a substrate, comprising:

a) providing a substrate having a substantially planar top surface;

b) applying masking means to a portion of said top surface, said masking means having a surface with a first surface relief pattern with said surface being adjacent to said planar surface;

c) applying a dispersion containing colloidal particles of selected shape and size to an unmasked portion of said top surface wherein said colloidal particles are drawn under said masking means by capillary forces and form a first colloidal crystal by self-assembly in void spaces between said surface and said masking means;

d) infiltrating a polymer into void spaces present between the colloidal particles in said colloidal crystal and curing said polymer; and

e) removing said masking means wherein said colloidal crystal pattern on said substantially flat planar surface defines a second surface relief pattern having raised portions.

76.(Original) The method according to claim 75 including applying a dispersion containing second colloidal particles of selected shape and size to said top surface wherein said second colloidal particles are drawn between said raised portions by capillary forces and form a second colloidal crystal by self-assembly between said raised portions.

77.(Original) The method according to claim 76 including removing said cured polymer.

78.(Original) The method according to claim 76 wherein said first colloidal particles are silica microspheres having a first diameter and said second colloidal particles are silica microspheres having a second diameter.

79.(Original) The method according to claim 78 wherein said second relief pattern in said masking means is a plurality of parallel, spaced apart channels so that the first colloidal crystal includes a plurality of substantially parallel and spaced apart first longitudinal beams formed from the colloidal spheres having said first diameter and located between adjacent first longitudinal beams are substantially parallel, second longitudinal beams formed from the colloidal spheres having said second diameter.

80.(Original) The method according to claim 78 wherein said second diameter is less than said first diameter.

81.(Original) The method according to claim 75 wherein after step c) said first colloidal crystal is dried prior to infiltrating said first colloidal crystal with said polymer.

82.(Original) The method according to claim 81 wherein said polymer is an ultra-violet curable polyurethane.

83.(Original) The method according to claim 82 including removing said cured polyurethane by heating said composite material.

84. (Original) The method according to claim 75 wherein the step of applying a dispersion containing second colloidal particles of selected shape and size to said top surface includes dipping said substrate into a liquid dispersion containing said second colloidal particles of selected shape and size, wherein said liquid dispersion includes a solvent having an effective evaporation rate, and wherein evaporation of said solvent induces directional mass transport of said colloidal particles between adjacent first longitudinal beams defined by said first colloidal crystal, wherein said colloidal particles spontaneously self-assemble and crystallize between raised features of said first

colloidal crystal, and removing said substrate from said liquid dispersion.

85.(Original) The method according to claim 84 wherein said substrate is dipped into said liquid dispersion so that said elongate channels are substantially vertical.

86.(Original) The composite material according to claim 4 wherein said spherical colloidal particles are selected from the group consisting of inorganic microspheres and polymer microspheres.

Claims 87-100 cancelled.

101. (Original) A method of producing a Lincoln Log Wood Pile superlattice, comprising

placing two polymer masks each having a parallel grooves in one face thereof face-to-face contact with said faces with said grooves being pressed together with the grooves in one face perpendicular to the grooves in the other face;

infiltrating a curable polymer into the grooves through capillary action, and curing said polymer and then removing one of said masks;

pressing the other mask against a substrate so said cured polymer is contacted

to said substrate, heating said polymer to above a glass transition temperature of the polymer mask, thereafter cooling said polymer and peeling said mask leaving behind a 3-D wood-pile structure on the surface of the substrate; and

exposing said 3-D woodpile structure to a liquid dispersion containing colloidal crystal particles which infiltrate into empty spaces of the wood-pile structure and self-assemble therein.